PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference AMS.P52317WO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB 03/04476	International filing date *(day/month/year)* 13.10.2003	Priority date *(day/month/year)* 12.10.2002
International Patent Classification (IPC) or both national classification and IPC G01V1/38		
Applicant WESTERNGECO SEISMIC HOLDINGS LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
07.05.2004	13.12.2004
Name and mailing address of the international preliminary examining authority: European Patent Offic D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Schneiderbauer, K Telephone No. +49 89 2399-7613

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB 03/04476

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

D scription, Pages

1-19 as originally filed

Claims, Numbers

1-24 received on 11.10.2004 with letter of 05.10.2004

Drawings, Sheets

1/9-9/9 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1,2,7-9,12,14-20,24
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-24
Industrial applicability (IA)	Yes:	Claims	1-24
	No:	Claims	

2. Citations and explanations

   s e separate sheet

1.) Reference is made to the following documents:

D1: US-A-4 641 287 (NEELEY WALTER P) 3 February 1987 (1987-02-03)
D2: US-A-4 376 301 (ROBERTS F ALEX) 8 March 1983 (1983-03-08)
D3: FR-A-2 620 536 (GEOPHYSIQUE CIE GLE) 17 March 1989 (1989-03-17)
D4: WO 84/03153 A (KONGSBERG VAPENFAB AS) 16 August 1984 (1984-08-16)
D5: COURT I N: "STREAMER COMPASS VALIDATION AND VERIFICATION" GEOPHYSICS, SOCIETY OF EXPLORATION GEOPHYSICISTS. TULSA, US, vol. 58, no. 4, 1 April 1993 (1993-04-01), pages 589-592, XP000367520 ISSN: 0016-8033

2.) Technical field: marine seismics

3.) Novelty (Art.33(1),(2) PCT) and inventive step (Art.33(1),(3) PCT) of the independent claims 1 and 12:

The present application does not meet the requirements of **Article 33(1),(2) PCT**, because the subject-matters of claim 1 and the corresponding method claim 12 are not new over the prior art as disclosed in D2 or D3.
D2 and D3 each disclose a method for determining the position of an acoustic receiver, comprising:
- determining a plurality of acoustic ranges (D2: col.4, li.35-38; D3: page 6, li.28-page 7, li.3)
- from at least a first signal source position and a second signal source position to the acoustic receiver (D2: fig.1, ref.28, 30; D3: fig.1b, ref. R1 and R2; page 5, li.29-33)
- ascertaining a non-acoustic constraint on the acoustic receiver's position (D2: depth detector or compass readings; col.4, li.38-40; D3: compass measurements with compass in cables; page 7, li.30 - page 8, li.4)
- and determining the acoustic receiver's position from the first and second acoustic ranges and the non-acoustic constraint (D2: col.4, li.35-40; D3: page 7, li.30 - page 8, li.4)
- the non-acoustic constraint being: an angular orientation of the acoustic receiver (D2: col.4, li.38-40: pinpoint the hydrophone position with the appropriate compass headings; D3: page 7, li.30 - page 8, li.4; compass in cable gives also indication of angular receiver orientation)

4.) The dependent claims:

4.1) The subject-matters of claims 2, 7-9, 14-20 and 24 are disclosed in documents D2 or D3 (s. also cited passages in the ISR) and are therefore not novel (**Art. 33(1), (2) PCT**).

4.2) The subject-matters of the dependent claims 3-6,10 , 11, 13 and 21-23 are not considered to be inventive (**Art. 33(1),(3) PCT**). They are either already disclosed in D4 (which describes the possibility of adaptively steering a streamer by mathematical modelling and a dynamic compensation for noise influence (D4; page 10, paragr. 3 and 4) or refer to conventional modelling techniques (s. also the applicant's statement on page 13 of his application, li.7-12).

5.) Industrial applicability (Art.33(1),(4) PCT):
Beyond any doubt the invention, as defined in claims 1-24, is industrially applicable.

Claims:

1. A method for determining a position of an acoustic receiver, comprising:

determining a plurality of acoustic ranges from at least a first signal source position and a second signal source position, respectively, to the acoustic receiver;

ascertaining a non-acoustic constraint on the acoustic receiver's position; and

determining the acoustic receiver's position from the first and second acoustic ranges and the non-acoustic constraint;

wherein the step of ascertaining the non-acoustic constraint includes one of sensing an angular orientation of the acoustic receiver, sensing a heading of the acoustic receiver, and retrieving a stored distance from a known second position to the acoustic receiver's position.

2. The method of claim 1 , wherein determining the acoustic receiver's position from the acoustic ranges and the non-acoustic constraint includes:

determining an intersection of a first sphere defined by the first signal source position, a second sphere defined by the second signal source position, and a plane defined by the non-acoustic constraint; and

selecting one point of the intersection.

3. The method of claim 2, wherein selecting the one point of the intersection includes one of determining the intersection of a third sphere defined by a third signal source position, determining a water depth at the acoustic receiver's position, and eliminating a second point of intersection as physically improbable.

4. The method of any preceding claim, wherein determining the position from the acoustic ranges and the non-acoustic constraint includes:

modelling the acoustic receiver's position from historical positions associated with the acoustic receiver's position; and

applying an inversion algorithm to constrain the modelled position with the non-acoustic constraint.

5. The method of claim 4, wherein applying the inversion algorithm includes applying a linear regression or a least squares fit.

6. The method of claim 4, wherein the acoustic receiver's position is determined dynamically as the position changes over time through the historical positions.

7. The method of any preceding claim 1 to 5, wherein the acoustic receiver's position is determined dynamically as the position changes over time.

8. The method of any preceding claim, further comprising performing the method for a plurality of points.

9. The method of claim 8, wherein the points are constrained to points on a cable.

10. The method of claim 9, further comprising determining the shape of the cable from the determined positions.

11. The method of claim 1, further comprising determining an acoustic range from a third signal source position.

12. An apparatus, comprising:

at least one acoustic source;

an acoustic receiver capable of receiving a plurality of acoustic signals transmitted by the at least one acoustic source from at least two signal source positions; and

a computing system programmed to determine a position of the acoustic receiver from the acoustic ranges between the at least two signal source positions and the acoustic receiver and a non-acoustic constraint;

wherein the non-acoustic constraint is one of an angular orientation of the acoustic receiver, a third acoustic range from a third signal source to the acoustic receiver, and a heading for the acoustic receiver.

13. The apparatus of claim 12, wherein the at least one acoustic source comprises an airgun.

14. The apparatus of claim 12, further comprising a sensor located at the position of the acoustic receiver to sense the non-acoustic constraint.

15. The apparatus of claim 14, wherein the sensor is one of an angular orientation sensing device and a heading sensor.

16. The apparatus of claim 14, wherein the sensor comprises one of means for sensing an angular orientation of the position and means for sensing a heading for the position.

17. The apparatus of claim 12, wherein the computing system is further programmed to analytically determine the position.

18. The apparatus of claim 17, wherein the computing system is further programmed to, for the acoustic receiver's position:

determine the intersection of a first sphere, a second sphere, and a plane, the first sphere and the second sphere being defined by the acoustic ranges and the plane being defined by the non-acoustic constraint; and

select one point of the intersection.

19. The apparatus of claim 18, wherein the computing system is further programmed to impose the non-acoustic constraint in selecting the one point of the intersection.

20. The apparatus of claim 17, wherein the computing system is further programmed to analytically determine the acoustic receiver's position dynamically as the position changes over time.

21. The apparatus of claim 12, wherein the computing system is further programmed to, for the acoustic receiver's position:

model the acoustic receiver's position from historical positions associated with the position; and

apply an inversion algorithm to constrain the modelled position with the non-acoustic constraint.

22. The apparatus of claim 21, wherein the computing system is further programmed to apply at least one of a linear regression and a least squares fit in applying the inversion algorithm.

23. The apparatus of claim 21, wherein the acoustic receiver's position is determined as the position changes over time through the historical positions.

24. The apparatus of claim 12, further comprising a cable on which the acoustic receiver is deployed.